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GB 2234362 A GB 2229828 A

(58) Field of search
UK CL (Edition K) G2C CHR CHX
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(54) Heat-sensitive recording medium

(57) A heat-sensitive recording medium comprises a substrate (1), a contrast enhancing layer (2), a thermally fusible layer (3), a thin metal layer (4) for forming visible information by being partially melted according to a desired pattern, a reversible thermal recording layer (5), a protective layer (6) and, optionally, a printed layer (7) between layers (5) and (6). When heated by means of a thermal recording head, visible information is formed in the thin metal layer (4), and also in the reversible thermal recording layer (5) due to changes in the degree of its optical transparency from the transparent state up to an almost opaque cloudy state, and retains its state after being cooled down so that desired visible information can be recorded on the layer. Therefore, according to this recording medium, re-writable information and unre-writable information can be recorded on a desired area by heating so as to cope with various applications of the visible information recording medium. Layer (5) preferably comprises a polymer and a C_{10-30} fatty acid or salt, ester or amide thereof.

FIG.2

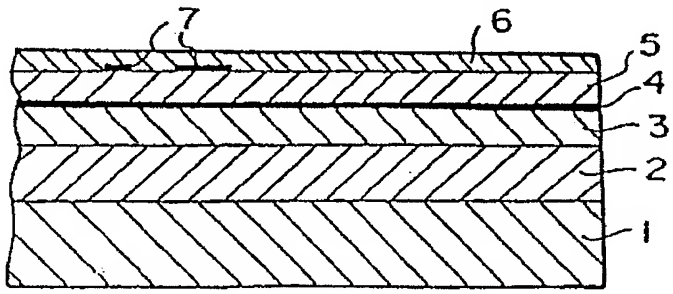

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FIG.1

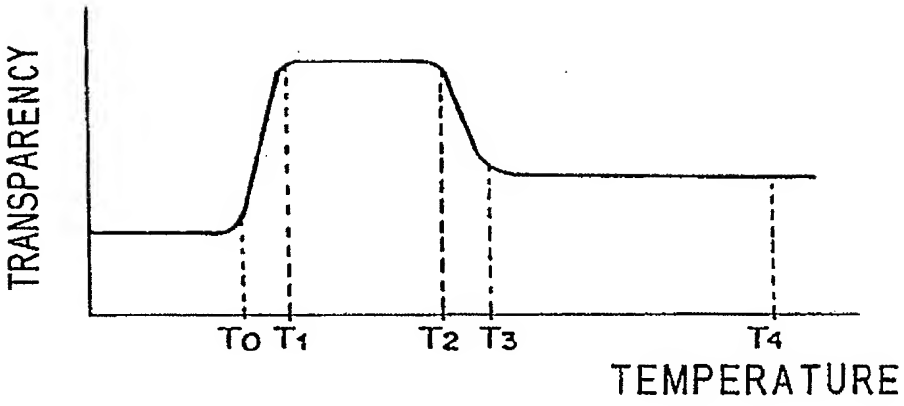
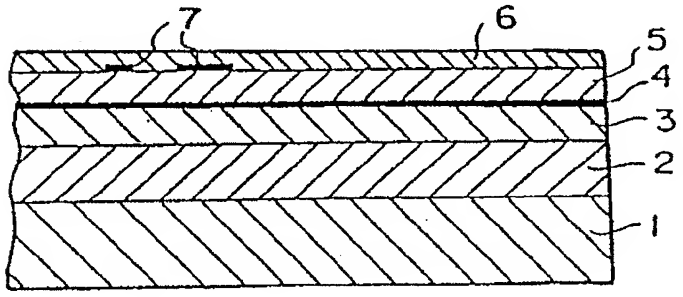


FIG.2



VISIBLE INFORMATION RECORDING MEDIUM

The present invention relates to a visible information recording medium, and more particularly to a card-type visible information recording medium which allows the information such as the service condition or the like to be visibly written thereon by means of thermal recording means. The visible information recording medium according to the present invention can be effective in particular to use for visibly recognizing the magnetically recorded content by, for example, printing the numerals and the like corresponding to the content of various prepaid magnetic cards.

As the prepaid magnetic cards have been widely used, a request has been increased to print the visible information such as characters, numerals or the like corresponding to its magnetically recorded content so that it can be visibly recognized. For example, when the prepaid card is used over a plurality of times, it is convenient if the user can visually confirm the service content or sum of money for each time and the outstanding credit or debt written within the card. In order to cope with such a request, a magnetic card has been developed which provides a heat-sensitive layer on which various information can be recorded by using

a thermal recording head (for example, Japanese Patent Laid-Open Hei 2-62287 and GB-A-2,238,901.

The prior art magnetic card of this type has, on the surface of either one of a plastic substrate, a contrast-enhancing layer, a thermal layer, a thin metal layer and a protective layer are sequentially provided. Thermal recording is conducted by making the thermal head of a thermal recording unit contact the surface of the protective layer. The heat given by the thermal head is transmitted to the thin metal layer via the protective layer and the second thermal layer to fuse part of it to provide a hole at the prescribed portion. Since the contrast-enhancing layer is positioned below the thin metal layer, this can be transparently visible through the hole portion, and the characters, numerals and the like each corresponding to the hole can be visually seen by their contrast to the hole-free portion.

The above-described conventional visible information recording medium is convenient in that the information such as the service condition can be visibly recorded but, when the temporary information, or the information which needs to be rewritten is recorded, one which has been recorded once needs to be erased once, and new information must be recorded on another area. However, since the area which can be used for recording is limited, the times for rewriting are restricted.

Therefore, it is desired to develop a recording medium which allows the information such as an ID information,

which cannot be rewritten, and the information which can be recorded depending on the service condition to be recorded.

According to this invention, a medium for recording visible information comprises:

a substrate ;

a contrast enhancing layer provided on at least either surface of the substrate;

an irreversible thermal recording layer provided above the contrast enhancing layer;

a thermally fusible layer provided adjacent to the irreversible thermal recording layer;

a reversible thermal recording layer provided above the irreversible thermal recording layer; and

a protecting layer for protecting the surface of the reversible thermal recording layer.

Preferably the reversible thermal recording layer is made of a material having different degrees of transparency according to the heating hysteresis so that, when heated to the temperature within a first range, which is higher than the normal temperature, and then cooled down to the normal temperature, it has higher transparency while when heated to the temperature within a second range, which

is higher than the above-described first temperature range, and subsequently, cooled down to the normal temperature, it has a lower degree of transparency.

The visible information recording medium according to the present invention comprises an irreversible thermal recording layer for irreversibly recording the information by the thermal recording means and a reversible thermal recording layer for reversibly recording, that is, rewritably recording the information by the same thermal recording means. When this reversible information recording medium is applied to, for example, a prepaid magnetic card, information such as the service breakdown or the like is recorded on the reversible thermal recording layer and, when it has been used up, signs indicating that it cannot be used is recorded on the irreversible thermal layer to prevent any card which has been used from being illegally used.

In a preferred embodiment of the present invention, the visible information recording medium takes may be in the form of a magnetic card, and has an arrangement in which a magnetic layer also having a function of the contrast enhancing layer, thermally fusible layer, reversible thermal recording layer and a protecting layer are sequentially provided. Thermal recording on the reversible thermal recording layer is conducted by making the thermal head of the thermal recording unit contact the surface of the protecting layer. Heat given by the thermal head changes the optical transparency of the protecting

layer for the reversible thermal recording layer, and visibly records desired information according to the difference of optical transparency at the protecting layer and the portion where no heat is given.

The thermally fusible layer provided adjacent to the thin metal layer has a function of dispersing or absorbing the fused metal when part of the metal thin layer is fused in order to irreversibly record the information thereon. Therefore, this layer, if adjacent to the metal thin layer, may be present either above or below it, or may be provided on both sides.

Such a reversible thermal recording layer can be formed by applying a mixture of a saturated or unsaturated aliphatic acid or its derivatives to a matrix comprising a polymer such as vinyl polymer or polyester to a proper thickness. This reversible thermal recording layer, when heat is applied thereto from the exterior, changes its optical transparency within a range from the transparent state up to an almost opaque and cloudy state according to its temperature, and retains the state after cooled down.

Therefore, the visible information recording medium according to the present invention allows the rewritable information and the unrewritable information to be recorded on the same or different arbitrary area so as to cope with various applications as the visible information recording medium.

A particular embodiment of the information recording medium in accordance with this invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a graphic view illustrating a relationship between the heating temperature and the transparency of a reversible thermal recording layer used in a reversible information recording medium of the present invention; and

Fig. 2 is a longitudinal view in partial cross section of the reversible information recording medium according to a specific embodiment of the present invention.

First, Fig. 1 illustrates a relationship between the heating temperature and the optical transparency of a representative reversible thermal recording layer which can be applied to the present invention. If the reversible thermal recording layer is heated to the temperature within a first range (T1 to T2) and then cooled down to the temperature of below T0, then this layer has its highest degree of transparency. Next, if, after this layer is heated up to the temperature within the second range, which is higher than T3, it is cooled down to the temperature of below T3, then it falls into a cloudy state in which the degree of transparency is the lowest. Further, if, after heated to within the range of T0 to T1, or the temperature within the range of T2 to T3, it is cooled down to T0 or less, then it exhibits various degrees of transparency which changes according to the heating temperature. That Is, this reversible thermal recording layer has the degree of transparency or opacity corresponding to its heating hysteresis. Here, the temperature T0 is somewhat higher

than the highest temperature at which the recording medium is exposed in the normal service condition. The change of this transparency is substantially completely reversible, and a desired degree of transparency can be obtained each time the heating and cooling are repeated.

Such a material for forming the visible thermal recording layer contains a resin matrix and an organic low-molecular weight compound dispersed therein. In this mixture, the material suitable as the resin matrix includes polyvinyl chloride polymer and copolymers of vinyl chloride and one or more kinds of vinylidene chloride, vinyl acetate, vinyl alcohol, maleic acid, acrylic ester, acrylonitrile and polyester.

A vinyl chloride/vinyl acetate copolymer sold under the trade name "VYHH" by Union Carbide Corp., Connecticut, U. S. A. is suitable for the matrix. In addition, the organic low molecular weight compound compounded within these resin components is selected from among the saturated or unsaturated aliphatic acids or their salts, esters, amides having about 10 to about 30 carbon atoms. The optimum organic low molecular weight compound is the aliphatic acid such as stearic acid, oleic acid or the like. It is possible to adjusting the temperatures T1, T2 and T3 freely in some extent by selecting the organic low-molecular compounds used.

The mixture may contain a dyestuff or pigment, as necessary.

On the other hand, when the irreversible information

is recorded, the thermal head of the thermal recording unit is made to contact the surface of the protecting layer to partially provide a hole through the thin metal layer. Since the contrast enhancing layer is located below the metal thin layer, this is transparently seen at this hole portion so that, by the contrast between the former and the hole-free portion, characters, numerals corresponding to the hole can be visibly seen. In this case, the heating temperature T4 is fairly higher than the maximum temperature T3 applied in order to change the degree of transparency of the reversible thermal recording layer.

Therefore, the recording medium of the present invention can applicable to various forms of recording, by recording using the variation of transparency of the reversible thermal recording layer upon usual application, and by recording information in the irreversible thermal recording layer when rewriting of the information is not necessary or not desirable.

A specific embodiment of the present invention is hereinafter described with reference to the accompanying drawings. Fig. 2 is a longitudinal view in partial cross section of a magnetic card according to a specific embodiment of the thermal recording medium of the present invention.

Referring to Fig. 2, a contrast enhancing layer 2, thermally fusible layer 3, an irreversible thermal recording layer 4, a reversible thermal recording layer 5 and wear-proof protecting layer 6 are formed on a surface

of a substrate 1 in that order.

If desired, a printed layer 7 may be provided between the reversible thermal recording layer 5 and the protecting layer 6 to form any arbitrary visual signs or pattern, as necessary.

As the material for the substrate 1, a synthetic resin sheet or synthetic paper made of, for example, polyethylene telephthalate, epoxy resin, polyvinyl chloride, polycarbonate or the like may be used.

The contrast enhancing layer 2 has a visual contrast relative to the irreversible thermal recording layer 4 and, if the irreversible thermal recording layer 4 is made of a silver white color thin metal layer, then it exhibits a dark color such as black or dark brown which shows a high contrast relative to this layer. As such material, an inclusion of pigment or dyestuff of any desired color within a binder resin, for example, polyester resin, alkyd resin, vinyl resin, polyurethane resin or a mixture of those resins may be used. The thickness of this contrast enhancing layer 2 is, for example, below 20 μ m, and preferably about 0. 5 to 15 μ m.

The thermally fusible layer 3 is provided to provide a sensitizing action to improve the recording characteristic when the visible information is written on the irreversible thermal recording layer 4 as well as disperse for storing the melted particles of the thin metal layer constituting material, which is melted during this writing. As those material, for example, a low-melting point natural resin

such as shellac, rosin, terpene resin or the like, or synthetic resins such as nitrocellulose resin, acryl resin, polyester resin, vinyl chloride resin, vinylidene chloride resin, vinyl acetate resin, polystyrene resin polybutyral resin, polyolefin resin or any combination thereof.

Those resins may contain one or more kinds of wax such as paraffin wax, microcrystalline wax, synthetic oxidized wax, montan wax, Fischer-Tropsch wax, low-molecular weight polyethylene wax, paraffin wax derivative, montan wax derivative, microcrystalline wax derivative or the like, and stearic acid, stearate or the like as the low viscosity additive. For such low-viscosity additive, one taking the form of fine particles is used by dispersing into the principal component, and the solid one is used by mixing or co-dissolving into the principal component by dissolving into a solvent or by melting by heating.

In addition, when it is applied as a coating agent, a solvent which does not attack other layers should be used. Such solvent may preferably selected from glycol ethers or alcohol solvents. The thickness of the thermally fusible layer 3 is preferably below 10 μ m, and more preferably about 0.5 to 5 μ m.

The thermally fusible layer may be present either on or below the thin metal layer, or may be provided on both sides.

The irreversible thermal recording layer 4 is provide as an unrewritable recording layer, which comprises a relatively low melting point metal, for example, tin,

formed by a vapor deposition technique so as to hide the contrast enhancing layer 2. The heating temperature T4 necessary to thermally destroy the irreversible thermal recording layer 4 is, for example, about 300 ℃ .

The protecting layer 6 is intended for protecting the surface of the magnetic card, and is formed of an excellently wear-proof and heat-resistant material such as cellulose resin, urethane resin, polyester resin, vinyl resin, epoxy resin, acryl resin or the like. Esters of phthalate, esters of aliphatic acid, esters of phosphates or the like may be added to these resins and, low-molecular weight polyethylene, oleyl amide, stearile amide, silicone and the like may be added to impart a slidability. In addition, when it is applied in the form of liquid or paste, a solvent therefor which do not attack other layers should be used. A suitable solvent may be selected from, for example, glycol ethers, or alcohol and the like. Incidentally, in order to decrease the amount of the solvent to be used, UV-hardenable type resin or electron rays-hardenable type resin such as acryl, epoxy, or polyester resin may be used. The thickness of this protecting layer 6 is, for example, below 10 μ m, and preferably about 1 to about 5 μ m.

The reversible thermal recording layer 5 is formed by dissolving a mixture essentially comprising the above-described matrix and the organic low-molecular weight compound into an organic solvent and drying after applied to a proper thickness. The mixture may include one or more

kind of surface active agent such as "FC-430" available from Sumitomo 3M Ltd. of Tokyo, Japan.

Preferable examples of formulates are listed below, all parts being given by weight.

(Formulate No. 1)

Vinyl chloride/vinyl acetate copolymer ("VYHH")	10. 0 parts
Docosanoic acid	10. 0 parts
Surface activating agent ("FC-430")	0. 1 part
MEK	60. 0 parts
Anone	60. 0 parts

The mixtures of the above-described components, after dispersed for four hours by means of a ball mill, was applied to a desired thickness by means of a bar coater #20 and then dried to form the visible thermal recording layer 5. The thickness of the reversible thermal recording layer 5, after dried, was about 4 to 6 μ m. In addition, the actually measured values of T1, T2 and T3 as shown in Fig. 1 were as follows:

T1: 70 ℃

T2: 80 ℃

T3: 110 ℃

(Formulate No. 2)

Vinyl chloride/vinyl acetate copolymer ("VYHH")	10. 0 parts
Docosanoic acid	5. 9 parts
Stearile stearate	5. 0 parts
Surface activating agent ("FC-430")	0. 1 part

MEK	40. 0 parts
Toluene	40. 0 parts
Anone	40. 0 parts

The procedure used for formulate No. 1 was repeated to obtain the visible thermal recording layer 5, which had the following transition temperatures:

T1: 60 ℃

T2: 80 ℃

T3: 100 ℃

(Formulate No. 3)

Vinyl chloride/vinyl acetate copolymer ("VYHH")	10. 0 parts
Docosanoic amine	10. 0 parts
Surface activating agent ("FC-430")	0. 1 part
MEK	60. 0 parts
Anone	60. 0 parts

The components were used to form the visible thermal recording layer 5 in a same manner as above. The temperature-visibility characteristics were as follows:

T1: 80 ℃

T2: 90 ℃

T3: 120 ℃

C L A I M S

1. A visible information recording medium comprising:

a substrate;

a contrast enhancing layer provided on at least one side of said substrate;

an irreversible thermal recording layer provided on said contrast enhancing layer;

a layer of thermally fusible material provided adjacent to said irreversible thermal recording layer;

a revisible thermal recording layer provided on said irreversible thermal recording layer; and

a protecting layer for protecting the outer surface of said reversible thermal recording layer.

2. A visible information recording medium according to claim 1, wherein said reversible thermal recording layer comprises a material having a different degree of transparency according to the heating hysteresis so that it exhibits a higher degree of transparency when heated to a temperature within a first range higher than the normal temperature, and then cooled down to the normal temperature, while exhibiting a lower degree of transparency when heated up to a temperature within a second range higher than said first range, and then cooled down to the normal temperature.

3. A visible information recording medium according to claim 1 or 2, wherein said reversible thermal recording layer comprises a mixture of a matrix comprising a polymer and an organic low-molecular weight compound.

4. A visible information recording medium according to claim 3, wherein said matrix comprises a resin selected from the group consisting of polyvinyl chloride; and copolymers of vinyl chloride and at least one of vinylidene chloride, vinyl acetate, vinyl alcohol, maleic acid, acrylic ester, acrylonitrile and polyester.

5. A visible information recording medium according to claim 3 or 4, wherein said organic low-molecular weight

or unsaturated aliphatic acids having about 10 to about 30 carbon atoms, and salts, esters and amides of said aliphatic acids.

6. A visible information recording medium according to claim 3, 4 or 5, wherein said mixture contains a dyestuff or pigment.

7. A visible information recording medium according to any one of the preceding claims, wherein said irreversible thermal recording layer comprises a thin layer made of a metal of relatively low melting point, which has a sufficient thickness to at least partially hide said contrast enhancing layer.

8. A visible information recording medium according to claim 7, wherein said irreversible thermal recording layer comprises a deposited tin layer.

9. A visible information recording medium according to any one of the preceding claims, wherein said contrast enhancing layer is a magnetic layer.

10. A visible information recording medium according to any one of the preceding claims, wherein said contrast enhancing layer includes a pigment or dyestuff of desired colour within a binder resin.

11. A visible information recording medium according to claim 10, wherein said binder resin is selected from the group consisting of polyester resin, alkyd resin, vinyl resin, and polyurethane resin or any combination of them.

12. A visible information recording medium according to any one of the preceding claims, which is in the form of a card.

12. A visible information recording medium substantially as described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) G2C(CHX)CHR

(ii) Int Cl (Edition 5) B41M

Search Examiner
M K B REYNOLDS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
27 AUGUST 1992

Documents considered relevant following a search in respect of claims
1-12

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2234362 A (KYODO) Figures	
A	GB 2229828 A (KYODO) Figures	

SF2(p)

GEM - doc99\fil000163

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

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